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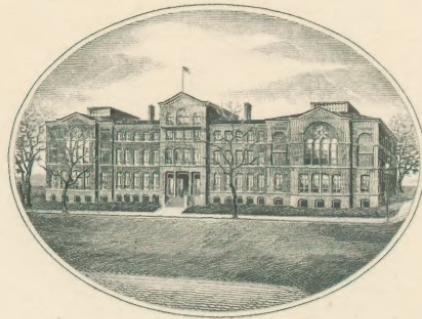
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LIFE:

WHAT DO WE KNOW ABOUT IT?

AN ESSAY,

READ BEFORE THE CHICAGO LITERARY CLUB, MAY, 1876.

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By H. A. JOHNSON, A.M., M.D.

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Annex

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LIFE:

WHAT DO WE KNOW ABOUT IT?

"A profound speculation, about the creation,
And organical life, and chaotical strife;
With various notions of heavenly motions,
And rivers, and oceans, and valleys, and mountains,
And sources of fountains, and meteors on high,
And stars in the sky — We propose by-and-by,
If you'll listen and hear, to make it all clear."

ARISTOPHANES.—*Frere's translation.*

"As I walk by the side of that vast calm river,
That awful river so dread to see;
I say thy breadth and thy depth forever
Are bridged by his thoughts that cross to me."

JEAN INGELOW.

Yesterday and to-morrow bound our lives. In either direction we seek to prolong our vision; to find what was, and what will be. Science, with uncertain vision, looks back through the dim vistas of the past, and forward into the gray dawning of a prophetic day, Faith looks up and beholds a noon-tide glory.

Have the twenty-three centuries that have

elapsed since the old Greek hurled his satire at the scientists of his age, brought to us any absolute knowledge concerning the genesis or ending of things? Between Lucretius and Tyndall how, if at all, have the atoms changed? The conditions of life have, to a great extent, been determined, but the question of its antecedents and consequents remains to vex philosophers and theologians. The poet's divine egg and a brooding chronos, is still to many a verity; to others only a pantheurgic function dominates the universe; while to a vast multitude the dream of the songstress, the vision of the shore beyond the river and the bridge, the thoughts of loved ones, are cherished as divine realities.

It is conceded by all biologists that there is a property, or an assemblage of properties, well marked and radical, distinguishing a plant or an animal from a crystal or a mass of amorphous matter. Substances having this property, we call living. Those that have it not, we call dead. Concerning this property, or principle, two theories have been held, each maintained with great vigor and supported by ingenious reasoning. The one, probably the older, asserts that all the phenomena which we call living are the direct results or manifestations of an immaterial force, in its essence separate from matter, and in no way dependent upon matter or the properties

of matter, material substances only furnishing the conditions for its manifestations. Various terms have been used to designate this principle, such as nature, plastic force, the spirit or principle of life, vital force. It is asserted that this force, or property, can, under certain circumstances, act upon and arrange in the forms of life the inorganic elements, oftentimes opposing its own energies to their motions, and preventing those chemical changes which, but for its presence or power, would take place among them. The existence of such a force, separate from matter, is inferred rather than proved.

The second hypothesis assumes that all the possible phenomena in compound bodies must be the result or equivalent of the properties of their chemical elements. In other words, that life is the result of organization, and that its possibilities are to be sought for in the ultimate atoms. As an ultimate atom can not make any impression upon our senses, and as its properties are inferred from the properties of the compound bodies into which it enters, it becomes evident that, as a solution of the problem of life, it is equally an inference.

From this it has happened that this question of life, its origin and the issues thereof, has been the battle-field where the best intellects of the race, through all the ages, have tested their

strength. Physics, or physics and metaphysics? Matter, or matter and mind? Is there a primary and single cause for all the phenomena which we know, and of all of which we are conscious, or is there a duality in life, at least a duality of force? The various answers to these questions by men equally honest, and I think we may assume of equivalent intellectual capacity, probably depend upon the different methods employed. Of the physicist, Huxley, Tyndall and others, by what they believe to be a rigid induction, reach the conclusion that all the phenomena of life, including emotion, thought, and consciousness, are the manifestations of the forces of what we call inorganic matter.

Dr. Carpenter, and I think a large number of physiologists, while recognizing the forces of brute matter in living forms, and the agency of these forces in stimulating functions or exciting activities usually considered to be the attributes of the immaterial part of our nature, are, nevertheless, forced to believe that there is in man at least something more than his body, and sharing with material forces the control of that body.

I believe only here and there one has ever been able, by any process of reasoning, to convince himself that there is no material world—no body, no objective reality. There seems to be a larger number who ignore an independent intellectual

existence. The contest, then, is not between matter and mind, but between matter alone and matter and mind conjoined.

The address by Professor Huxley, delivered in Edinburgh, in 1868, and the remarkable address by Professor Tyndall, before the British Association in Belfast, contains perhaps the most clear and positive statement of the modern scientific school relating to life — vegetable, animal and spiritual. An earnest, and I believe, an honest, effort is made to answer, if possible, the question: What is life? Whether or not this effort has been, to any extent, successful, is a matter upon which thinking men are by no means in accord. It will perhaps be useful to examine the propositions and arguments of these acknowledged leaders in material science, with a view to determine how much they can help us in the study of this problem. Professor Huxley's address, though the shorter of the two, seems to me to contain about all that can be said upon the subject. It has for its title "On the physical basis of life," by which he means a substance consisting chemically of carbon, hydrogen, oxygen and nitrogen, and which has been produced by the combination of these elements in some unknown way, under the influence, or in the presence, of preëxistent living forms. This substance he calls "protoplasm," and makes it include all the forms of organic matter enter-

ing into the composition of the animal body, or used by animals as food, and all the organic substances of vegetables. He applies this term "protoplasm" to organic matter in both its living and dead state. Living man is protoplasm, and boiled lobster is equally protoplasm. The growing grain and the baked bread receive the same appellation. He assumes that if there is a common material basis for all animals and plants, this basis, in every position, should have something common in power or function. There should also be a common unit of form, as well as a common chemical constitution, or, in the language of the address, "a threefold unity, namely, a unity of power or function, a unity of form, and a unity of substantial composition." Believing that this unity exists, he infers from it, first, a common origin for all life, and second, the material character of that origin. Let us follow his statements of the unities.

So far as the powers of living things are concerned, he states that they are comprised in the functions of nutrition, of motion or contractility, and of reproduction. He includes under the term motion not only sensible changes of form, but states of sensation, emotion, reasoning, and, if I understand him rightly, also willing. Subjective phenomena are known, except to ourselves, only by motion. He admits that we do not certainly

know that all plants have this property of contractility or motion, but thinks we shall know it "when the vegetable world is thoroughly explored."

That all living forms have the functions of nutrition and reproduction he assumes as an admitted fact, but proceeds somewhat at length to discuss the function or property of contractility of organic forms, using for illustration the stinging hair of the common nettle. From the wonderful movements of these minute masses of living matter he infers that all other forms of living matter are in constant motion, and that "so far as the conditions for the manifestation of contractility have yet been studied they are the same for the plant as for the animal," and that "the difference between the powers of the lowest plant or animal and those of the highest is one of degree, not of kind." The great difference, he does not expressly say the only difference, between plants and animals being that plants can produce protoplasm from inorganic substances, while animals can only use protoplasm ready made and existing in plants or other animals. Professor Huxley admits that of the conditions upon which this difference in the two divisions of the world of life depend we know nothing.

Admitting this wide distinction, and confessing

ignorance of the reason for it, he nevertheless asserts that with only this qualification "it may be truly said that the acts of all living things are fundamentally one."

This statement closes his argument upon the unity of function. He next proceeds to the subject of form, illustrating it by reference to the white blood corpuscle and other similar bodies in animals and vegetables, and concludes that "so far as form is concerned, plants and animals are not separable," and "that protoplasm simple or nucleated is the formal basis of life."

So far, Professor Huxley claims that he has established the proposition "that all living powers are cognate, and that all living forms are fundamentally of one character."

The essential identity of chemical constitution of all living forms is maintained not so much from absolute proof as by inference. It is admitted that the living form must die before it yields to the chemist the secret of its constitution, but it is insisted that this fact of death does not in any important particular vitiate the result. By the chemist then it is proved that all protoplasm is, in the language of the author, "more or less albumenoid."

The forms of life are unstable, they are destroyed by their manifestations of life itself. In this cyclical history they all agree.

This completes the proof of the threefold unity of all living structures — common function, common form and common substance. In addition, a common destiny, Death, awaits them all; therefore they all must or do have a common origin. He next endeavors to show that it is reasonable to believe that all the properties and attributes of living things, from the lowest to the highest, are the resultants of the molecular forces of the material atoms entering into their composition. The argument is one from analogy. The properties of water are believed to depend upon the properties of the gases oxygen and hydrogen, and that no outside element, or property, has been added to the compound in the act of its production. This belief rests upon the evidence of analysis and synthesis. Is there any such foundation for the belief that the properties of living forms do depend upon, or come from, the properties of the organic matter of which, chemically, they are composed? Professor Huxley attempts to show that this is at least probable. He cites the fact that inorganic substances are changed by vegetables into organic, that these organic compounds are converted into forms of animal life, that they may be separated again into inorganic elements to be again built up into living structures. We have here the evidence of analysis and synthesis, and according to the professor, the analogy between

the production, for instance, of water from the two gases, by the agency of the electric spark, and the production of a man, by the agency of a progenitor, is such as to justify the inference, that if the properties of water are due, as they confessedly are, to the properties of the molecules of oxygen and hydrogen that chemically constitute it, so are not only the forms of beauty but the sentiment of love, the deductions of reason, and the consciousness of existence only the development of properties hitherto dormant but essentially belonging to the variously combined molecules of carbon, hydrogen, oxygen and nitrogen.

I believe I have correctly stated the proposition of the author. That he does not limit the term vital to vegetative life, or mere animal life, as usually understood, will be evident from the statement with which he closes this part of his address. He says, "and if this be so," namely, that all vital action is the result of molecular force, "it must be true in the same sense, and to the same extent, that the thoughts to which I am now giving utterance, and your thoughts regarding them, are the expression of molecular changes in that matter of life which is the source of our other vital phenomena." Professor Huxley admits that this is the language of materialism, and the remainder of the address is

devoted to an effort equally honest, I believe, to show how he can hold these doctrines and be no materialist. The substance of it is that he uses the terms of matter to express the idea of spirit, believing that scientific truth is better and more surely reached by such a use of words. Matter containing potentially mind, it is of little consequence which we employ, provided only that we understand what is meant. The symbols of his thought, being material, conduct him to the conclusion that his thought itself is only a property of matter. Translate the symbol and matter becomes translated into mind.

Professor Tyndall's address deals to some extent with the same ideas, but seeks in the history of philosophy for a reinforcement of the conclusions.*

The argument is also based upon a consideration of the order in nature, the mode of formation of the physical universe. No where do we find the evidence of any intrusion of a creative power into the successive stages. As we have not seen this process of creation, we have no right to assume it.

Physical science has furnished an explanation for many phenomena which were formerly believed to be supernatural. The conquests of

* For an able statement of the Conquest of Science, see Professor White's Address, *Pop. Sc. Monthly*, February and March, 1876.

science in the past are prophetic of what will be in the future.

The masterly ingenuity and vast learning of Darwin have made it quite evident that forms of life are modified by physical conditions. If forms are modified, so must be forces, and if physical conditions can and do change forms and modify forces, why not produce them? The doctrine of the conservation of energy, in the language of the author, "exacting from every antecedent its equivalent consequent, and from every consequent its equivalent antecedent," probably will lead to the establishment of causal relations in the world of life as well as in that of matter. He quotes, apparently with approval, Herbert Spencer's definition of life, "a continuous adjustment of internal relations to external relations." He seems to think that states of consciousness are only the results of physical influences acting upon the series of the race and extending through immense periods of time. Intelligence is probably made up of the almost infinite number of physical impressions received and recorded, not by the race only, but by successive races; and man in his totality, mind and body, is only the amount of a very small sum placed at compound interest away back in the babyhood of the world. Where this small principal came from, the Professor does not tell

us, but he seems to think the doctrine of spontaneous generation not proved. His more recent studies have apparently confirmed his doubts as to the production of living organisms *de novo*. What he claims is that even in living forms the matter is arranged by physical forces, or, in his words, "self posited," as are the molecules of a crystal. In the Belfast address he is conducted, by what he believes to be the necessities of science, to the conclusion that in common matter we have "the promise and potency of all terrestrial life."

Professor Huxley and Professor Tyndall both expressly admit, that to make this proposition tenable, something must be added to the common idea of matter; but they claim that our knowledge of matter is by no means exhaustive, and that as there are rays from the sun that make no impression upon our visual organs, so there may be properties and forces in the material world to which man has no responsive sense, but that in the far-off future, when by slow increments of now unperceived impressions a new organ or new organs shall have been developed, then shall be revealed to our astonished minds not only the machinery but the machinist in the busy workshop of life.

The positions of Huxley and Tyndall may be summed up as follows:

I. All living forms have common functions; nutrition, reproduction and motion, or contractility.

II. All living structures have a common unit of form—nucleated or non-nucleated protoplasm.

III. All living matter is of the same chemical constitution. From which we may infer that as all these forms have a common destiny, sinking into the world of matter—death—so have they a common origin—resurrection from matter—life.

IV. Compound bodies in the inorganic world have only the properties derived from their elements—water for instance. In the absence of any proof to the contrary, we ought, from analogy, to believe the same to be true of a mass of protoplasm living or dead, and of all combinations of such masses, since all such combinations are only made up of multiples of the formal unit.

V. We can find no substance but matter, and no force but such as is connected with matter. All bodies which we call living are material, and all actions which we call vital, even the highest, are known except to the subject of them, only through matter. Hence, all living things and forces come from matter, and the student of material science will, in the language of Professor Tyndall, “wrest from theology the entire domain of cosmological theory.”

Are these propositions of Professor Huxley concerning protoplasm scientifically proved? If so, do they, with Professor Tyndall's facts and reasoning, establish the truth of the proposition that in inorganic matter are imprisoned all the properties and attributes, from the lowest to the highest, of living things?

Counter facts and objections have been urged by such men as Stirling, and Martineau, and Beale, in the old world, and many writers in America. Let us endeavor to group these objections and see to what extent, if any, they should modify these claims of physical science.

The first proposition of Professor Huxley, namely, that all living forms have common powers or functions, and that the difference between the different masses of protoplasm are differences in degree, and not in kind, of function, would, if proved, render physiology a very simple science. It seems hardly possible that even Professor Huxley himself can believe that the function of secretion, as of urine for instance, or bile, by the cells or masses of protoplasm of the kidney or liver, is in kind the same as the function or emotion of pleasure in beholding a beautiful picture or a magnificent sunset. Neither by the microscope nor by the instruments of precision furnished by mechanics, has it been demonstrated that either the one or the other is

essentially an act of contraction, or that the two acts or states have anything in common; only one of them, in fact, is the subject of consciousness. If there be but one function, that of contractility, the degree of function, which according to Professor Huxley constitutes the only difference between the powers of the lowest plant or animal and those of the highest, should only give us a difference in quantity of motion or force, as the weight of a cannon is greater than that of a pistol, or as the weight or force of a man is greater than that of an infant. We ought to find among living things only one species, one variety even, differentiated only by the quantity of force or power. Or if this is thought to be a too rigid adherence to the literal meaning of the term *contractility*, or motion, we should at least be able to show, in accordance with the admitted principle of the conservation of energy, how this property of pleasure, to use a term of materialism, is the equivalent of protoplasmic contraction. If the powers of all protoplasm are fundamentally one, with common nutriment, how does it happen that we have any differentiation even in the same individual,—why should there be mucus and muscle, liver and lungs, bone and brain? If, as Mr. Huxley expressly states, "in the earliest condition of the human organism, in that state in which it has just become distinguishable from

the egg in which it arises, it is nothing but an aggregation of such corpuscles," that is, of protoplasm, how comes it that from these masses, with identical powers, such widely different forms should be produced? If the ova, protoplasm, of all living things are alike, why should not the egg of a bird live and hatch in a trout stream, and why should it not become an elephant? Why should not men gather figs of thistles or grapes of thorns? It will perhaps be said, in fact has been said, in explanation, that the differentiation depends entirely upon forces external to the protoplasmic cell or mass, and that the reason for the wonderful variety in living forms must be sought for in cosmic forces, acting slowly through long periods. But how does this help explain the matter? Why should this long series of cosmic influences in any way produce permanent mechanical combinations and differentiations of work out of a great number of masses of living matter, each having only common functions? Can all the variety of work in the manufacture of so simple a thing, for instance, as common muslin, be accomplished by a great number of workers, each of whom can do only one and the same thing? But Professor Huxley admits, as we have seen, that there is a difference in the powers of the protoplasm of plants and animals. Plants can manufacture protoplasm

from the inorganic elements, while animals can only use that already formed. It would seem, therefore, that the power or capacity of the plant is greater than that of the animal, and that there is, even according to the Professor himself, a notable exception to his dogma of the unity of function. He does not seem to think, however, this exception of much consequence, and does not know upon what condition it depends.

In view of the impossibility, with present knowledge, of proving that every mass of protoplasm has the power of every other mass of protoplasm—in view of the fact that there seems to be a difference in the power of different masses of protoplasm, in different animals, and even in different parts of the same animal—and in view of the fact that the protoplasm of plants is known to have powers that the protoplasm of animals is not known to have—and in view of the further fact that no one knows why the protoplasm of the animal can not do all that the protoplasm of the plant can do, therefore, I think we ought to say, that as a scientific statement, this proposition, that “the acts of all living things are fundamentally one,” is not proved.

His second proposition asserts that all protoplasm has a common form, by which I do not understand him to mean identically the same relation in space of length, breadth and thickness,

like the form of a crystal, but rather a kind of matter common to animals and plants, and in all conditions agreeing in general physical characteristics. The white blood corpuscle is described as the type of form. I think any histologist who will carefully follow Professor Huxley will be obliged to admit that the description is exceedingly indefinite, and that in order to predicate of all living matter a common form, many minor differences must be left out of the consideration. The description is rather generic than specific. There are great difficulties, it is true, in the way of the establishment of specific differences. Bodies $\frac{1}{3000}$ of an inch in diameter may seem to be very much alike in form and constitution, and yet may, in many respects, be very unlike. Beale, and Stricker, and other histologists, who have had the largest experience in the use of high magnifying powers, and who, by long study, ought to be able to interpret what they see, are by no means certain that this unity of form exists. In fact, many good observers are quite confident that it does not exist. Mr. Huxley describes protoplasm in the sting of the nettle as granular, Beale and Stricker maintain that it is homogeneous, and that there are no granules, except such as are accidentally present. All who have studied these minute living forms admit that they vary wonderfully in consistence, in form or shape, and

in size. Observers are by no means agreed as to the essential part: whether cell wall, or nucleus, or contained matter between wall and nucleus—whether the unformed or formed matter.

In this uncertainty and disagreement among experts in the use of the microscope, and the interpretations of its revelations, I think we must admit that there remains a residuum of doubt, and that the proposition "that all living forms are fundamentally of one character" can not be accepted as a statement of discovered fact.

The proposition that the protoplasm of all living things is alike in chemical constitution, is also extremely vague. The statement is true only in a very general and loose sense. Even if the ultimate analyses gave for all protoplasm the same elements in the same proportions, still it would not necessarily follow that we could predicate of it identity of chemical constitution, for there are allotropic states of matter, chemical changes which do not appear when we come to weigh and test the ultimate elements. There are different modes of combination of the same definite proportions of atoms producing bodies quite dissimilar in physical qualities. Mr. Huxley embraces in his definition of protoplasm substances that are in fact widely different in chemical constitution; nerve tissues, fibers and cells, are quite unlike, in their chemistry, the organic

matter in bone and cartilage; unlike not only in the proportions of the four elements, carbon, hydrogen, oxygen, and nitrogen, but in the fact of the presence of new elements. Phosphorus, for instance, as an element of brain tissue and saline matters in variable proportions, in all the different structures of the body. Different parts are differentiated by differences of chemistry as well as by different forms and uses. The Professor, after stating his proposition, and adducing such proofs as seem to him convincing, says: "To the complex combination, the nature of which has never been determined with exactness, the name of protien has been applied, and if we use this term with such caution as may properly arise out of our comparative ignorance of the things for which it stands, it may be truly said that all protoplasm is proteinaceous," or as he adds, "more or less albumenoid." Very much is implied in the three words, "more or less." It is not proved then that all protoplasm has an identity of chemical composition. Rather the contrary is proved and, by inference, admitted by the author of the physical basis of life.

From this examination of Mr. Huxley's premises we are forced to the conclusion that the three-fold unity of all living matter, of function, of form, and chemical constitution, is not known to be true; that neither of the propositions is

made so evident as to justify its acceptance as a scientific fact; and that the conclusion of a common origin for all living things, so far as that conclusion rests upon the established truth of these propositions, is a *non sequitur*.

In each particular, of function, of form, and of substance, there are so many modifications and qualifications, so many unknown factors, and such irreconcilable paradoxes, that we are justified in denominating it only an ingenious theory, made plausible to the casual reader by a vague use of terms.

Assuming, however, that such a unity may exist, for we have only endeavored to show that it has not been proved to exist, what reason have we to believe that the properties of life, from the lowest to the highest, are nothing else than the properties of the molecules of matter that make up the forms of life? That growth, reproduction, and all life action, from amœboid contraction to the reasoning of Kant and Hamilton and Huxley, are only the liberated energies of so much crude life-stuff, a kind of nitro-glycerine explosion, brought about by the action upon this dead matter of a brooding time, and effecting "a continuous adjustment of internal relations to external relations"?

The reasoning has been stated, but it will bear a repetition.

Water is composed of oxygen and hydrogen. It bears no resemblance to the gases from which it is formed, yet every body admits that its properties are dependent upon, or are derived from, its elements. No one thinks of inventing a term, aquosity, for instance, as something either matter or force, added to oxygen and hydrogen, to account for these new properties of water. Living forms are composed of carbon, hydrogen, oxygen and nitrogen. They bear no resemblance, it is true, to the elements from which they are produced, neither does water to its elements. The gases to form water are mixed in due proportions, the electric spark is passed through them, and we have water.

Carbon, hydrogen, oxygen and nitrogen are brought together in the presence of a living form, and we have living matter.

We may therefore just as reasonably believe that the properties called vital in living matter are the outcome of its elements, as that the properties of water are the outcome of its elements, and that vitality has no better claim to a distinct recognition than aquosity, or, in the language of the author, "if the phenomena exhibited by water are its properties, so are those presented by protoplasm, living or dead, its properties." Professor Huxley makes no distinction between "living" and "dead."

Let us examine a little this argument. The electric spark converts the two gases into water, something which is not electricity, and which no one has ever claimed to be electricity. The living form converts the four elements into something identical with itself, that is, a form of life. Is there between these two propositions such a parity as to justify the Professor's conclusions? How far are the two processes analogous? In the one case, *a*, electricity, determines the combination of the elements *b* and *c*. The product — water — has only the properties derived from the elements *b* and *c*, and not of its determinant — electricity. In the other case a living form determines the combination of the four elements *b*, *c*, *d* and *e*, and the product — living matter — has the properties derived from the four elements *b*, *c*, *d* and *e*, + the properties of the determinant — living form.

In the one case the determinant — electricity — produces a substance — water — not having the properties of the determinant, but only of its material elements.

In the other case the determinant — living matter — produces a substance — living protoplasm — having the properties of its material elements, + the properties of the determinant.

In order to make the analogy good we must admit the existence of a life force, or of some

force in the living matter of the determinant, and deny its presence in the living form produced. The product should differ from the determinant as water differs from electricity.

Let us invert the form of the argument.

Living matter produces from inorganic matter a substance, life matter, having like properties with itself. Electricity produces from inorganic matter a substance, water, which, though it does not seem to be electricity, must nevertheless, from the analogy, be electricity. It is true the compound seems to be water, but this is only a popular delusion, for if the product of the combination of the four elements under the influence of living matter has the property of its producer, namely, life, so must the product of the combination of the two elements, under the influence of electricity, have the property of its producer, namely, electricity. This conclusion ought to satisfy the Professor. He seems to think that this analogical argument is a very strong one. He seems also to have overlooked the fact that in applying it to protoplasm he has not recognized the admitted difference in quality of this substance in different conditions. He predicates of dead protoplasm only the potential properties of its elements, and then, apparently forgetting that the difference, if any, between living and dead is still *sub judice*, is in fact the cause to

be determined, he proceeds to beg the whole question to span the gulf between life and death by the fairy structure of his own imagination. The analogy forces him to the avowal that he "can find no intelligible ground for refusing to say that the properties of protoplasm result from the nature and disposition of the molecules." And this, notwithstanding the fact that in function, in form, and in chemical constitution, all protoplasm has not been proved to be alike, and notwithstanding the further fact that the analogy between the formation of water and protoplasm, between the property of "aquosity" and "vitality," is at least a very loose one.

With, however, all this positiveness of knowledge, he recognizes a mystery. He admits that in the higher manifestations of life "volition counts for something as a condition of the course of events." Does he mean here to admit that there is in the human mind a force independent of protoplasm and not coming from it? His atoms, like the dove to the ark after long wanderings over the desolate sea, seem to have come back from their dreary effort to gather themselves up, from the chasing of shadows and the following of phantoms, to find a sure rest in the fiat of will. The order of nature is one thing, but its cause even his wonderfully active molecules can

not, by any process of perpetual motion, find in themselves.

As a scientific statement of the facts of the case, we are compelled to pronounce the address upon protoplasm a failure. As a logical argument it does not establish the probability even of his conclusions, for it must be remembered that to overthrow the testimony of consciousness and the common-sense convictions of not the ignorant only, but of the educated and thinking world upon this subject, the truth of the premises should be conclusive, and the reasoning rigorously exact. Mr. Huxley claims for his statements the authority of science, and attempts to build upon them a logical unanswerable argument. In fact, the premises are only statements of possibilities, and the logic is in many respects faulty.

In further proof of the physical basis of life, both Professor Huxley and Professor Tyndall insist that as we can not find the property of life outside of matter, and as all living phenomena are known, except to the subject of them, only through matter, therefore we ought to believe that all life actions do find their equivalent antecedents in the properties or forces belonging to the atoms that in combination make up living things. The finely-divided matter filling the vast

depths of space, is to these men pregnant with all creeping things, with all beautiful flowers, with all birds of the air and all beasts of the field and forest; nay, more, potentially our joys and our sorrows, our hopes and our fears, our ideas of space and time, our thoughts concerning all these things, are as certainly the efflorescence and fruitage of dust, as the snow, the amethyst and the diamond, built into temples of beauty, are the products of molecular force.

The theory is certainly both complicated and simple. We must start somewhere and somehow, and the difficulty is to get that start. But only once set in motion this "continuous adjustment of internal relations to external relations," and organized atoms, like a snow-ball in Spring, accumulate rapidly. It is very easy and simple to find, through the eons of past duration, ample time and scope for the wonderfully complex results. By a process of nature the whole is evolved. An eye is produced because, away back through countless ages, the atoms, by some mysterious interaction, experienced a prophetic thrill, and waited long for the coming prince, the trembling beam whose gentle pressure should mold into shape and proportion cornea and iris and lens and retina. Here is what we call artifice, and we seek for the artificer, but we are told that diligent search has been made in and

about the temple, and he can not be found, and consequently he is not.

But let us look at the proposition that we can not find any evidence of life except through matter, or connected with matter. What does this mean? Certainly neither Huxley nor Tyndall would admit that there are no properties or forces except those that impress our senses. They both think there are such properties now unknown, and probably unknowable, and that mysteries are to be explained by such occult forces. The statements seem to me to mean simply this: We do know some things about matter, but we do not know how much there is about matter of which we are ignorant. In this ignorance, however, we will assume that every phenomenon connected with matter, whether of motion or form, or of whatever quality, is only the outcome of material properties. It is true we have a conscious existence, but even this comes from matter, because we do not know that this very consciousness exists except as a property of our bodies.

This reasoning seems to be the counterpart of that idealism that rejects entirely an external world. Indeed, Mr. Huxley seems to think that it is of no consequence, except as a matter of convenience, whether we adopt the one or the other of these extremes—pure idealism ignoring

matter, except as a form of thought, or pure materialism ignoring alike sensation, emotion and intellect, except as attributes of matter. He seems, like one of those intermediate organisms of which he speaks, to live in a kind of "no man's land," with the shore of a real ocean on one side and a mirage of the desert on the other. This whole difficulty of life-matter seems to result from the presence, in living forms, of, so far as we now know, either two unknown quantities, or one unknown quantity in two different conditions.

In matter, dead matter, we have known properties represented by α , unknown properties, according to both Professors, represented by x ; dead matter, therefore, equals $\alpha+x$. Living forms contain dead matter, $\alpha+x$, and have, in addition, life, which may provisionally be represented by y . In dead matter x is unknown; in living matter, which contains dead matter, x is unknown, and y is unknown, and as x and y are both unknown they may be equal to each other, or they may be one and the same. Hence, says the scientist, they are equal, or one and the same. I think even Professor Tyndall would hardly admit, from the premises, the legitimacy of the conclusion.

To Professor Tyndall's claim that science "will wrest from theology the entire domain of cosmological theory," it may be answered that most

theologians of the present day concede to science the right to determine, if possible, the order of creation, to find out how the universe has been formed, and the causal relations of matter. But there is another series of facts to our consciousness equally evident with those of matter, which lead us to the primal cause of all things and all phenomena—the Whence. Concerning this series material science can, by its methods, determine nothing, can not even make evident its existence. It is because the student of nature has entered this field without recognizing the fundamental differences between it and the world of matter, that he has reached conclusions so at variance with the common sense of mankind, and before which he himself stands appalled. It will always be so, so long as he attempts to subject mental and religious truth to the same kind of reasoning, and the same crucial tests that he does the theories and phenomena of the material universe. He can not, by his instruments, measure the height of joy or the depth of despair—weigh in his scales the sentiment of hope or the tenderness of love. He can not determine, by any of his methods, the existence even of the sweet quality of pity, or the gentle graces of charity. To his acids, and alkalies, and protoplasmic compounds, the soul may be ~~related~~ related, but yields no obedience. The effort to derive from the

experience of material things, by any process of abstraction, a knowledge of these phenomena, will always, we think, be futile. The mind has no right to "cross the boundary of experimental evidence," and pass, in so doing, from the world of matter to the world of thought. If we project our reasoning into the unknown, we must be careful that we do not misplace the terms of that unknown—that we do not predicate of *y* what, by analogy even, we can only infer of *x*. Matter is admitted; Thought is admitted; their ~~relations~~ relations are admitted. Because we can not see how they take hold of each other we have no right to say that the one is subordinate to the other. This wide difference in the two series of phenomena should be recognized by every student of biology, and it is the failure to sufficiently note this distinction that constitutes the most objectionable features of what has been called the tendency of modern thought, or the new philosophy. The proposition to determine by physical methods the states of feeling and reasoning, and all mental acts, seems to be preposterous because we say these acts have nothing to do with matter. But, says the Professor, there is a correlation between every mental act and the physical condition of the brain, and knowing anatomically and chemically the condition of your brain, it would be scientifically possible to know

your thought and your feeling, for function must wait upon physical states. To this there is no answer if thought and feeling are properties of matter. But, on the other hand, what if matter is only a form of thought. We may as well exclude the one as the other.

These addresses, and the writings of Spencer, Darwin and others, have been the occasion of much discussion and of some impatient and unkind criticism. That the effort to answer the question, *What is life?* has been an honest one, I have no doubt. That the effort has not been successful seems to me to be quite evident. The question, in fact, embraced too much. Had it been limited to simple vegetative life and the order of its production, the methods of science would so far have been legitimate, and the results, whether evolution or separate and successive creations, we think, of little consequence; but when it is made to include feeling and thought, factors are introduced that may be correlated with matter, but which return no answer to material questionings. Life, then, is confessed, even by science, to be a mystery, a *terra incognita*, bounded on one side at least by matter, brute matter, but on the other side by some thing, as it seems to me, finer and better than Professor Tyndall's "streaks of morning cloud" and "infinite azure." I can find no definition that will cover it all. The

forces of the material world are evidently projected into its forms and become, not as Professor Tyndall seems to think, the masters of the mind, but its gentle ministers. The phenomena of matter, and the phenomena of thought, are both the subjects of knowledge and of control. Both the thing, and the thought about the thing, are recognized by consciousness. How the thought and the thing hang together is the wonder of wonders. Both Huxley and Tyndall, by their own admission, stand in the presence of this marvel. They confess that the theories they have framed do not satisfy all the cravings of their nature. They feel that there is an immaterial soul, but they listen in vain for its whisperings in the chamber of the dead. They try to believe that there is a universal Father, but they can not find him in his material universe. In the presence of birth and death they invoke an image of clay. It is true they do not claim that men and elephants are produced spontaneously. They admit that, as far as we now know, the proposition *omne vivum ex vivo*, may be true; that one of the conditions of the mystery is the presence of an antecedent living form, a parent germ, a tiny cell, perhaps, bearing within its little casket across the gulf of death the precious burden of a new life; but notwithstanding all this, they

claim to be only evolved dust. Whatever may be their desires, their hopes or their fears, they accept by a law of necessity, this as the only conclusion to which their science leads them. For my own part I can not admit their premises proved; the argument seems to me to be evidently unsound, and the conclusion not true. I fully believe that we have a dual nature. I no more question the existence of mind than I do that of matter. Though related here in time and space, I believe they are independent in their essence. The two existences seem to me to be in harmony, and I can hardly conceive of the universe without them both. Matter is to me as it is to Huxley and Tyndall, a sign of thought, but not its cause. The inorganic masses are instinct with a mysterious form of energy. Planets pursue their trackless course around the central sun in an ever-varying path, receiving variable quantities of light and heat, obedient to a central and to disturbing forces. The sun himself, with all his attendant train, is but one of a mighty host whose solemn tread, from age to age, echoes along the aisles of heaven, while all-pervading light, a gentle angelus, bears on trembling wing through the depths of space, from star to star, a divine message. Our world is but a microscopic cell in this vast body, and

ourselves are indeed living atoms, connecting links between the infinite thought and the material expression of that thought.

As in the wide sea wave follows wave because the breath of heaven has fallen upon the waters, so in this restless race of life individual follows individual, but we must believe that it is because the spirit of the All Powerful first brooded upon chaotic matter, and set in motion, and has sustained through uncounted eons, this everlasting surge of being.

Let, then, the Spencers and Darwins, and Tyndalls and Huxleys, work out modes of motion, and determine, as far as they can, the order of creation. Let us not require that they shall find in anatomy and physiology and physics the evidence of man's immortality. The proofs do not lie within the domain of their investigation. The answers which they bring to our questionings should be accepted as probably the only ones that can, even by torture, be wrested from matter. Admitting that these answers do not satisfy all the conditions of the complex problem of life, they must leave it to other hands, by other methods, to complete the work.

Let the Butlers and Hamiltons, and their host of co-workers in the fields of thought and feeling, grapple with the mystery of the soul and its

future, each in his own way, employing his own methods and applying his own tests, and, when he has reached the limit of his knowledge, let the gifts of science and the offerings of religion, with reverence and humility, be laid upon a common altar, and the best answer that man can give shall be found to the great question of yesterday, to-day and the hereafter.

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